Design of Highly Reliable PLC Based Automatic Drilling Machine for Industrial Automation to Optimize Wooden Plank Circular Cross Section Cutting Process

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Abstract: -At this time, there is a huge development in the automation industry and their associate and relevant machinery to improve the productivity. The hand held or conventional methods involving man power is still in use in industry application like in small, medium and in large mass productive industries for drilling. Drilling is a process by which we cut the surface of any soft or hard material in circular form with the help of a drill bit to make a hole of circular cross section area of it. Drill bit is a type of rotating cutting tool, usually comes with different hole sizes. When force or pressure is applied on the drill bit against the work piece it starts rotating, and its rotation is counted or estimated at rates from few tens to thousands of revolutions per minute. Most of the industries use the old and conventional method for drilling. This conventional method is very time taking process, low accurate and consume more labor cost, and gives low production. So there is a huge scope to develop the machine for drilling operation for some industrial application.

Keywords: PLC, simulation software mircovin step-7, conveyor assembly, drill bit, relay, limit switches, DC motor, wooden plank, eagle software, etc.

I. INTRODUCTION

As the newest and modern development of technology has been introduced, the high precision and speed is needed for drilling machine to drill on hard material and surfaces of any object. For this purpose, an improved, efficient and high performance drilling machine should be developed to meet and satisfy the demand of requirement with time. In view of satisfying the requirements of users in automation industries for drilling machines, the PLC tools have been introduced in industries to make precision machine for drilling machines. Easy and normal drill machines such as man operated manual portable drilling machines; Electric operated drilling machines are very common. We can see this type of machines almost at every home. Often these machines are used for drilling through hole over the job; these machines cannot be used for number of machining operations for specific applications. Labor work or force is essential to drill and make hole on the material surface. Due to human power the depth of the drilling cannot be measured properly and mistakes may be encountered during manual or hand held operation, the work done may be damaged due to human mistakes and without changing the drill bit we cannot make different size holes. This process consumes more time for different hole sizes which are repeated respectively. These are the drawbacks of manual operation by human being. As we know the mass production is to be done in automation industries, the labor work power is very costly in recent time. It gives extra financial load, which is not acceptable and affordable. To come out from all these problems, this prototype for automated drilling machine has been designed which is very well suited to drill the holes automatically over a surface of any material to make a job.

Our objective is to build a Hardware working prototype of an Industrial Drilling Machine used for drilling holes in a plank either of wood or metal from the sideways as per the use. Here we will display a machine which drills on a wooden plank placed on a conveyor belt by automatically sensing it on the plank and performing a drilling operation on the plank.

II. SYSTEM DISCRIPTION

Schematic Diagram and System Process

The detailed schematic diagram of the process is shown below, which consists of a Conveyor Belt, Motor, Pulleys, Drilling Machine panel, Saw and Roller arrangement and the Control panel for all the Three Switches that are Puss OFF, Push ON and Emergency Stop.

Whenever the Push ON Button is pressed the Conveyor Belt starts to move. It continues to move until the Wooden Plank placed on the Belt is sensed by the Proximity Sensor placed on the Clamp. The Clamp comes over and holds the Plank for the Drilling Operation. The Drill machine moves downward for the process and after the process is done the Machine again starts to move upward. After the Drilling process the clamp the removed and the Conveyor again start to move.

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Moreover a additional switch is present for stopping the Machine. Whenever the stop switch is pressed the machine stops its operation and reset to the initial position.



Figure1 Schematic Diagram

The whole hardware of the system consist a Conveyor Belt, Drill Stand & Drilling Machine. The picture of whole diagram is shown below:



Figure 2:- drilling assembly

We are using PLC system to control the relay of all the motors, drill and sensing module. The PLC platform gives the eco-friendly environment to the user. A programmable logic controller or PLC is a digital computer controlled device which is used for performing the operation and functions such as arithmetic operations, logical control like ladder or bit logic, to perform sequencing, timing and counting etc. for controlling industrial processes for specific applications in automated factory assembly lines. PLCs are used in many plants and machines, in many industries. PLCs have been designed for many inputs and outputs. They work according to given instructions and commands. PLCs are interfaced with input and output with actuators and sensors. These physical or electrical signals given to PLC and after that PLC reads the instructions and after reading and scanning of instructions, it executes the operation with reference to input. Programs and instructions are stored in memory of PLC which is non -volatile memory. A PLC is real time monitoring and controlling systems which produce the results in response to input conditions within a certain time, otherwise non predictable results may occur.

Previously, when PLCs are not in use, the controlling, sequence of logic, timing, counting and safety interlock logic for manufacturing and production in industries was mainly done by the relays, timers, and close loop controllers. Since long time or years, the process for updating technology and adopting such facilities for every year was consuming times and costly for the electrician to do maintenance of relays for their operation characteristics

Digital computers have been much popularized to control the industrial processes and applications. In early age of computers they required technically sound programmers and well suited operating atmosphere such as

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temperature, clan environment and power quality. The high protection is required when we use the general purpose computers for process control operations in any plant in hazards conditions. Therefore we use industry purpose digital computers which have many attributes to support the users to operate process operations. It can tolerate the plant floor environment, it supports the input output instructions and commands for execution of the program, and it has not requirement of long training to operate system. It is also suitable to monitor the operation of process in plant. The speed of response is fast and it is very useful to control operations with faster speed. The response time is varied according to the nature of process. It has modern electronic and digital controllers which provide the reliable outputs with high precision and accuracy within milliseconds times. PLC has set of instructions for automatic start and stop operation of any machine. We can also use timers for executing instructions. The 0-1 edge of the input IN is delayed by the time PT at the output Q. The output Retains 0 levels if the input IN returns to 0 levels before the time PT has elapsed. The time elapsed can be consulted at the output ET and the preset time value at the Input PT can be modified when the timer is running.



Figure 3:-hardware setup for experiment



Figure 4:- On delay timer time cycle



Figure 5:- Programmable Logic Controller trainer

III. SOFTWARE IMPLEMENTATION

STEP 7 Microwin V4.0 is the standard software package used for configuring and programming SIMATIC programmable logic controllers. It is part of the SIMATIC industry software.

STEP 7 is the subject of this documentation; STEP 7 Micro is described in the "STEP 7 Micro/DOS" documentation. The programming languages Ladder Logic, Statement List, and Function Block Diagram for S7-300 and S7-400 are an integral part of the standard package. Ladder Logic (or LAD) is a graphic representation of the STEP 7 programming language. The Ladder Logic of the whole project is as follows:



Figure 6:- Ladder logic program for proposed process

IV. I/O PROGRAMME, INSTRUCTION AND DISCRIPTION

Table -1 Programmed Input Descriptions	Table -1	Programmed	Input I	Descriptions
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INPUTS				
Sr. No.	Input Number	Description		
1.	I0.0	Push ON Button		
2.	I01	Wood Detection Sensor		
3.	I0.2	Clamp Front Limit Switch		
4.	I0.3	Stand Low Level Limit Switch		
5.	I0.4	Stand High Level Limit Switch		
6.	I0.6	Clamp Back Limit Switch		
7.	10.7	Push Off Button		

Table -2 Programmed Output Descriptions

OUTPUTS				
Sr. No.	Output Number	Description		
1.	Q0.4	Conveyor Motor		
2.	Q0.5	Stand Upward Direction Motor		
3.	Q0.6	Stand Downward Direction Motor		
4.	Q0.7	Clamp Forward Direction Motor		
5.	Q1.0	Clamp Backward Direction Motor		
6.	Q1.1	Drill Machine		

Table-3 Step-By-Step Methodology

METHODOGY (Step-By-Step)					
Sr.	Input		Output		
No.	Description	Number	Description	Number	ON\OFF
1.	Push ON	I0.0	Conveyor	Q0.4	ON
2.	Wood Detection Sensor	I0.1	Conveyor	Q0.4	OFF
			Clamp Forward	Q0.7	ON
3.	Clamp Front Limit	10.2	Clamp Forward	Q0.7	OFF
			Stand Down	Q0.6	ON
			Drill Machine	Q1.1	ON
4.	Stand Low Limit	10.3	Stand Up	Q0.5	ON
			Stand Down	Q0.6	OFF
			Clamp Reverse	Q1.0	ON
			Conveyor	Q0.4	ON
			Drill Machine	Q1.1	OFF
5.	Stand High Level	I0.4	Stand Up	Q0.5	OFF

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6.	Clamp Back Limit	I0.6	Clamp Reverse	Q1.0	OFF
7.	Push OFF Button	10.7	Conveyor	Q0.4	OFF
			Stand Up	Q0.5	OFF
			Stand Down	Q0.6	OFF
			Clamp Forward	Q0.7	OFF
			Clamp Reverse	Q1.0	OFF
			Drill Machine	Q1.1	OFF

V. APPLICATION AND ADVANTAGES

The project is mainly used in the industry where mass production of anything which have a hole or drill in it. This project mainly serves to reduce the Labor and increase the efficiency and precision in the work piece. This is free from Environmental Effects as it uses PLC rather than any other Controller. This is a prototype of the automatic drilling machine with some minor adjustments this can be useful in many areas like:

- Wood industry
- Foundry Practices
- Industrial Machining Workshops
- PCB and IC industries

VI. RESULT AND CONCLUSION

The working hardware prototype of the industrial grade drilling machine is partially successfully made which works on the almost full efficiency to drill or make a hole in the work piece placed over on the conveyor belt. We have made almost 80% efficient, accurate and precise project for the mentioned objective. This project helped us to learn how we can solve the problems for the initial set up of automatic drill machine for any project. We have faced lot of initial problems like software and hardware problems. Now we have been familiar to its software and hardware designing with better accuracy and precision. And also a lot of things regarding many fields of engineering such as mechanical, electrical, electronics, mechatronics and also to overcome with the practical problems incurred during making of the project

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